E 1.28: SOLAR/1056-78/12

SOLAR/1056-78/12

Monthly Performance Report

M. F. SMITH ASSOCIATES

DECEMBER 1978

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT

M. F. SMITH ASSOCIATES

DECEMBER 1978

I. SYSTEM DESCRIPTION

M. F. Smith Associates is a single-family residence in Jamestown, Rhode Island. The home has approximately 2240 square feet of conditioned space. Solar energy is used for space heating the home and preheating domestic hot water (DHW). The solar energy system has an array of flat-plate collectors with a gross area of 512 square feet. The array faces 15 degrees west of south at an angle of 45 degrees to the horizontal. Water is the transfer medium that delivers solar energy from the collector array to storage and to the space heating and hot water loads. Solar energy is stored in a 3150-gallon concrete storage tank. City water is preheated in storage and in heat exchanger HW1, which receives energy from a coil at the output of the heat pump compressor. Preheated water is supplied, on demand, to a conventional 82-gallon DHW tank. Solar-heated water from the storage tank is directed to a heat pump or to an hydronic heat exchanger to provide space heating. When the storage water temperature is insufficient to satisfy the heat pump input requirements, an electrical heating element (booster unit HR1) in the line between storage and the heat pump provides auxiliary energy. During the cooling season, heat is removed from the conditioned space and discharged into storage, which should be maintained below 100°F by operating the collector system at night. An electrical heating element in the DHW tank provides auxiliary energy for water heating. The system, shown schematically in Figure 1, has three modes of solar operation.

Mode 1 - Collector-to-Storage: This mode activates when the temperature difference between the collectors and the bottom of storage is 20°F or higher. Pumps P1 and P2 circulate water from the storage tank through the collectors and back. Circulation continues until the temperature difference between the collector and storage falls to 5°F or less. If the temperature in a collector panel reaches 45°F, the collector array drains down.

Mode 2 - Storage-to-Space Heating: This mode activates when the manually set thermostat in the conditioned space zones 1 and 2 indicates a demand for heat. Pump P3 circulates water from storage to the heat pump in the energy conservation module (ECM). If the input water temperature is higher than 90°F, the water will be diverted to an hydronic heating coil. If the water temperature is less than 90°F, the water will be diverted to the heat pump.

Mode 3 - DHW Preheating: This mode activates when city water enters a heat exchanger in the storage tank and flows to the HW1 preheater which receives energy from a coil at the output of the heat pump compressor inside the ECM. When there is no draw, the ECM internal pump circulates hot water from HW2 to HW1, as long as HW1 remains hotter than HW2. If a draw occurs, water flows from HW1 to HW2 for a final temperature boost.

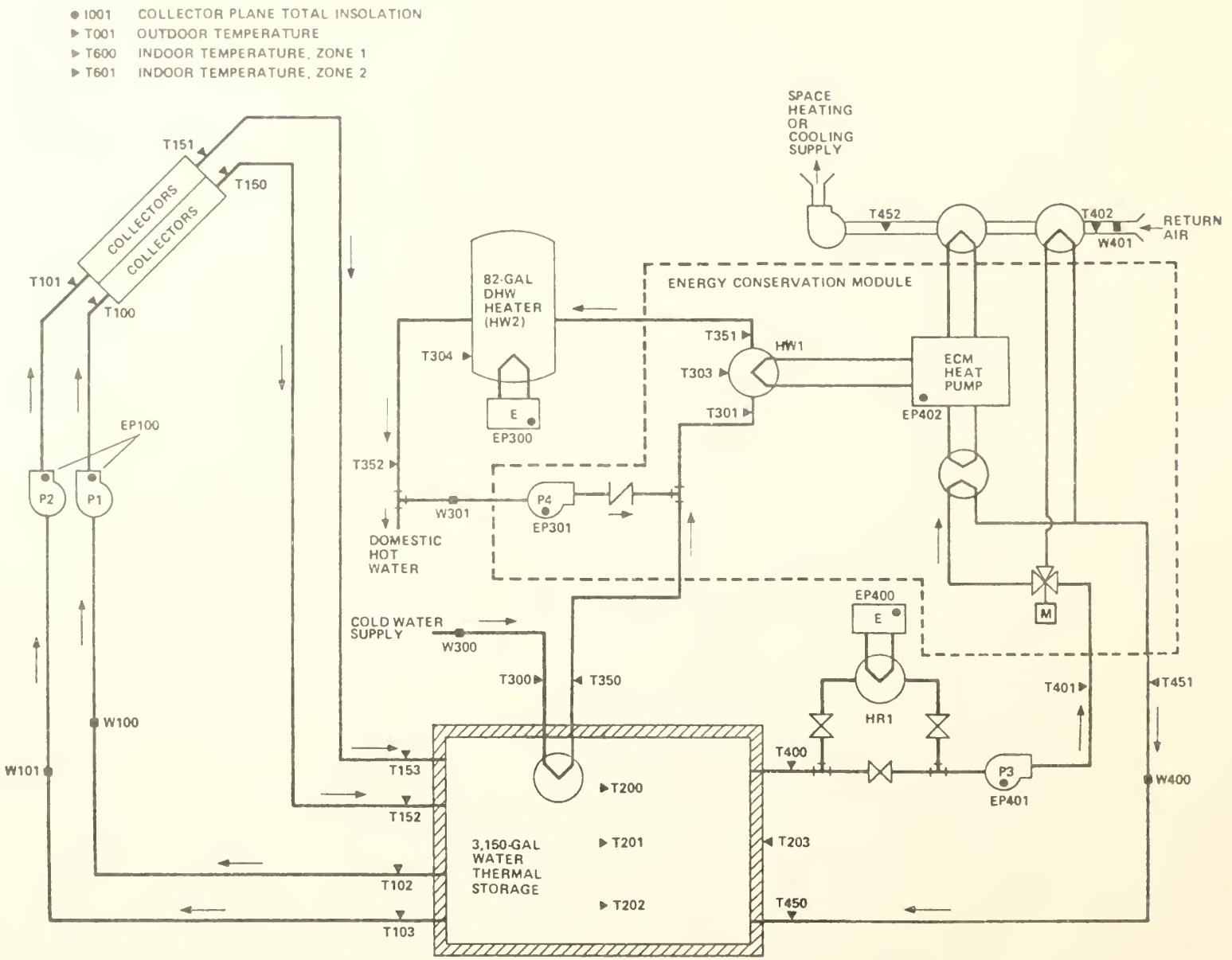

Figure 1. M. F. SMITH SOLAR ENERGY SYSTEM SCHEMATIC

II. PERFORMANCE EVALUATION

INTRODUCTION

The site was unoccupied in December and the solar energy system operated continuously during the month. Solar energy satisfied 73 percent of the space heating requirements. There were no DHW requirements. The solar energy system provided electrical energy savings of 2.4 million Btu. The energy collected cannot be accurately determined due to the placement of collector loop flowmeters relative to the drain-down solenoid valves (located in parallel with the collectors). This condition causes a problem when the drain-down valves are opened during periods of collector loop operation. The value used for solar energy collected is the amount of energy delivered to storage from the collector array.

WEATHER CONDITIONS

During the month, total incident solar energy on the collector array was 16.8 million Btu for a daily average of 1060 Btu per square foot. This was above the estimated average daily solar radiation for this geographical area during December of 951 Btu per square foot for plane facing 15 degrees west of south with a tilt of 45 degrees to the horizontal. The average ambient temperature during December was 36°F as compared with the long-term average for December of 33°F. The number of heating degree-days for the month (based on a 65°F reference) was 885, as compared with the long-term average of 984.

THERMAL PERFORMANCE

Collector - The total incident solar radiation on the collector array for the month of December was 16.8 million Btu. During the period the collector loop was operating, the total insolation amounted to 14.7 million Btu. The total collected solar energy for the month of December was 5.6 million Btu, resulting in a collector array efficiency of 33 percent, based on total incident insolation. Operating energy required by the collector loop was 0.18 million Btu.

Storage - Solar energy delivered to storage was 5.6 million Btu. There were 6.4 million Btu delivered from storage to the space heating subsystem. During December there was a storage energy gain attributed to the uninsulated storage tank located in the warmer surroundings of the dwelling. The average storage temperature for the month was 55°F.

DHW Load - There was no DHW load during the month.

Space Heating Load - The space heating subsystem consumed 6.4 million Btu of solar energy and 2.4 million Btu of auxiliary electrical energy to satisfy a space heating load of 8.9 million Btu. The solar fraction of this load was 73 percent. The space heating subsystem consumed a total of 1.5 million Btu of operating energy, resulting in an electrical energy savings of 2.6 million Btu.

OBSERVATIONS

During December the hydronic coil was not used for space heating because of the low storage temperatures. There was continuous heat pump operation, except for approximately 33 hours during the month, to maintain the 67°F average building temperature with a 36°F average ambient temperature. Booster unit HR1 did not come on during the month. The input water temperature to the heat pump was as low as 42°F.

On most days during the month, there were indications that during collector loop operation the flow shunted the collectors through the drain-down valves. The shunting usually occurred for several hours after initiation of collector loop flow. This condition is believed to be caused by set point problems with the drain-down freeze-protection controls which allow the drain-down valves (located in parallel with the collectors) to be open during periods of collector loop operation.

ENERGY SAVINGS

The solar energy system provided a net electrical energy savings of 2.4 million Btu. The space heating subsystem contributed an electrical energy savings of 2.6 million Btu.

III. ACTION STATUS

The grantee is expected to investigate the drain-down freeze-protection control problem.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND SOLAR/1056-78/12
REPORT PERIOD: DECEMBER, 1978

SITE/SYSTEM DESCRIPTION:
THE M.F. SMITH SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND DOMESTIC HOT WATER. THE SYSTEM USES WATER AS THE ENERGY COLLECTION, TRANSFER AND STORAGE MEDIUM. SOLAR HEATED WATER FROM THE STORAGE TANK IS DIRECTED TO A HEAT PUMP EXCHANGER TO PROVIDE SPACE HEATING. AN ELECTRIC BOILER PROVIDES AUXILIARY HOT WATER AS REQUIRED. MAKE-UP WATER FOR THE DHW SYSTEM PASSES THROUGH A HEAT EXCHANGER IN THE STORAGE TANK AND THEN TO A PRE-HEAT TANK. THE SOLAR HEATED WATER IS TRANSFERRED TO THE ELECTRIC HOT WATER TANK AS REQUIRED.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	16.823 MILLION BTU
	32856 BTU/SQ.FT.
COLLECTED SOLAR ENERGY	5.589 MILLION BTU
	* BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	36 DEGREES F
AVERAGE BUILDING TEMPERATURE	67 DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	0.38
ECSS OPERATING ENERGY	0.181 MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	1.674 MILLION BTU
TOTAL ENERGY CONSUMED	9.691 MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	-0.000	8.857	N.A.	8.857 MILLION BTU
SOLAR FRACTION	50	73	N.A.	73 PERCENT
SOLAR ENERGY USED	-0.000	6.429	N.A.	6.429 MILLION BTU
OPERATING ENERGY	0.000	1.493	N.A.	1.674 MILLION BTU
AUX. THERMAL ENERGY	0.000	2.428	N.A.	2.428 MILLION BTU
AUX. ELECTRIC FUEL	0.000	2.428	N.A.	2.428 MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. MILLION BTU
ELECTRICAL SAVINGS	-0.000	2.558	N.A.	2.377 MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.648

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM, FEBRUARY 28, 1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND
REPORT PERIOD: DECEMBER,1978

SOLAR/1056-78/12

SITE/SYSTEM DESCRIPTION:
THE M.F. SMITH SOLAR ENERGY SYSTEM PROVIDES SPACE HEATING AND DOMESTIC HOT WATER. THE SYSTEM USES WATER AS THE ENERGY COLLECTION, TRANSFER AND STORAGE MEDIUM. SOLAR HEATED WATER FROM THE STORAGE TANK IS DIRECTED TO A HEAT PUMP EXCHANGER TO PROVIDE SPACE HEATING. AN ELECTRIC BOILER PROVIDES AUXILIARY HOT WATER AS REQUIRED. MAKE-UP WATER FOR THE DHW SYSTEM PASSES THROUGH A HEAT EXCHANGER IN THE STORAGE TANK AND THEN TO A PRE-HEAT TANK. THE SOLAR HEATED WATER IS TRANSFERRED TO THE ELECTRIC HOT WATER TANK AS REQUIRED.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	17.748 GIGA JOULES
	373118 KJ/SQ.M.
COLLECTED SOLAR ENERGY	5.897 GIGA JOULES
	* KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	2 DEGREES C
AVERAGE BUILDING TEMPERATURE	19 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	0.38
ECSS OPERATING ENERGY	0.191 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	1.766 GIGA JOULES
TOTAL ENERGY CONSUMED	10.224 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	-0.000	9.344	N.A.	9.344 GIGA JOULES
SOLAR FRACTION	50	73	N.A.	73 PERCENT
SOLAR ENERGY USED	-0.000	6.782	N.A.	6.782 GIGA JOULES
OPERATING ENERGY	0.000	1.575	N.A.	1.766 GIGA JOULES
AUX. THERMAL ENG	0.000	2.561	N.A.	2.561 GIGA JOULES
AUX. ELECTRIC FUEL	0.000	2.561	N.A.	2.561 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	-0.000	2.698	N.A.	2.508 GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.648

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SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND
REPORT PERIOD: DECEMBER, 1978

SOLAR/1056-78/12

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	0.730	35	0.180	N	0.007	N	0.240
2	0.627	44	0.193	O	0.006	O	0.297
3	0.277	33	0.243	T	0.003	T	0.834
4	0.069	55	0.111		0.000		1.472
5	0.329	43	0.164	A	0.005	A	0.461
6	0.898	44	0.142	P	0.008	P	0.150
7	0.521	43	0.139	P	0.006	P	0.256
8	0.153	52	0.124	L	0.003	L	0.739
9	0.061	45	0.156	I	0.000	I	2.378
10	0.522	27	0.244	C	0.005	C	0.442
11	0.490	24	0.282	A	0.008	A	0.549
12	*	*	*	B	*	B	*
13	0.522	31	0.243	L	0.007	L	0.433
14	0.439	34	0.210	E	0.009	E	0.452
15	0.412	39	0.195		0.008		0.491
16	0.636	42	0.155		0.008		0.251
17	*	*	*		*		*
18	1.284	28	0.322		0.010		0.238
19	*	*	*		*		*
20	0.146	30	0.266		0.004		1.693
21	0.280	42	0.207		0.005		0.661
22	0.883	34	0.246		0.008		0.270
23	0.888	37	0.219		0.008		0.242
24	0.405	34	0.206		0.005		0.485
25	0.273	40	0.252		0.004		0.869
26	0.924	34	0.195		0.008		0.205
27	0.753	30	0.263		0.006		0.332
28	0.955	27	0.375		0.006		0.379
29	0.913	25	0.276		0.008		0.309
30	0.698	31	0.238		0.007		0.330
31	0.107	40	0.220		0.000		1.962
SUM	16.823	-	6.714	N.A.	0.181	N.A.	-
AVG	0.543	36	0.217	N.A.	0.006	N.A.	0.382
NBS ID	Q001	N113			Q102		N111

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND SOLAR/1056-78/12
REPORT PERIOD: DECEMBER,1978

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	0.730	0.677	0.261	39	0.357
2	0.627	0.571	0.225	50	0.359
3	0.277	0.201	0.038	31	0.137
4	0.069	0.019	0.000	55	0.000
5	0.329	0.275	0.092	46	0.281
6	0.898	0.847	0.360	51	0.400
7	0.521	0.448	0.174	48	0.334
8	0.153	0.088	0.024	54	0.154
9	0.061	0.017	0.000	44	0.000
10	0.522	0.393	0.121	29	0.233
11	0.490	0.410	0.105	28	0.215
12	*	*	*	*	*
13	0.522	0.453	0.173	35	0.333
14	0.439	0.400	0.120	38	0.273
15	0.412	0.378	0.132	43	0.320
16	0.636	0.586	0.248	47	0.390
17	*	*	*	*	*
18	1.284	1.197	0.426	31	0.332
19	*	*	*	*	*
20	0.146	0.072	0.008	32	0.055
21	0.280	0.230	0.098	46	0.352
22	0.883	0.843	0.363	38	0.411
23	0.888	0.845	0.375	44	0.423
24	0.405	0.318	0.112	38	0.276
25	0.273	0.174	0.073	41	0.266
26	0.924	0.875	0.367	37	0.397
27	0.753	0.642	0.233	33	0.310
28	0.955	0.833	0.310	30	0.325
29	0.913	0.843	0.357	31	0.391
30	0.698	0.627	0.253	38	0.362
31	0.107	0.019	0.000	43	0.000
SUM	16.823	14.702	5.589	-	-
AVG	0.543	0.474	0.180	40	0.332
NBSID	Q001		Q100		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND SOLAR/1056-78/12
REPORT PERIOD: DECEMBER, 1978

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.261	0.175	0.088	61	1.007
2	0.225	0.186	0.035	63	0.984
3	0.038	0.231	-0.162	60	1.827
4	0.000	0.101	-0.049	56	1.000
5	0.092	0.152	-0.024	55	1.385
6	0.360	0.135	0.211	59	0.959
7	0.174	0.134	0.024	63	0.900
8	0.024	0.113	-0.079	62	1.458
9	0.000	0.146	-0.104	59	1.000
10	0.121	0.231	-0.069	56	1.331
11	0.105	0.269	-0.092	52	1.683
12	*	*	*	*	*
13	0.173	0.226	-0.121	49	0.602
14	0.120	0.198	-0.019	45	1.502
15	0.132	0.202	-0.007	45	1.483
16	0.248	0.160	0.115	47	1.107
17	*	*	*	*	*
18	0.426	0.306	0.143	53	1.053
19	*	*	0.043	*	*
20	0.008	0.248	-0.162	50	10.742
21	0.098	0.185	-0.017	47	1.707
22	0.363	0.239	0.142	50	1.047
23	0.375	0.215	0.177	55	1.043
24	0.112	0.196	-0.083	57	1.020
25	0.073	0.238	-0.108	54	1.786
26	0.367	0.189	0.185	55	1.021
27	0.233	0.250	-0.042	58	0.892
28	0.310	0.362	-0.019	57	1.106
29	0.357	0.283	0.062	58	0.967
30	0.253	0.230	0.017	59	0.977
31	0.000	0.209	-0.150	56	1.000
SUM	5.589	6.429	-0.069	-	-
AVG	0.180	0.207	-0.002	55	1.138
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
HOT WATER SUBSYSTEM

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND
REPORT PERIOD: DECEMBER, 1978

SOLAR/1056-78/12

DAY OF MON.	HOT WATER LOAD MILLION BTU	SOLAR FR.OF LOAD PER CENT	SOLAR ENERGY USED MILLICN BTU	OPER ENERGY MILLICN BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLICN BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	SUP. WAT. TEMP DEG F	HOT WAT. TEMP DEG F	HOT WATER USED GAL
1	0.000	0	0.000	0.000	0.000	0.000	N	0.000	N	60	140	0
2	0.000	0	0.000	0.000	0.000	0.000	O	0.000	O	60	140	0
3	0.000	0	0.000	0.000	0.000	0.000	T	0.000	T	60	140	0
4	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
5	0.000	0	0.000	0.000	0.000	0.000	A	0.000	A	60	140	0
6	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	60	140	0
7	0.000	0	0.000	0.000	0.000	0.000	P	0.000	P	60	140	0
8	0.000	0	0.000	0.000	0.000	0.000	L	0.000	L	60	140	0
9	0.000	0	0.000	0.000	0.000	0.000	I	0.000	I	60	140	0
10	0.000	0	0.000	0.000	0.000	0.000	C	0.000	C	60	140	0
11	-0.000	50	-0.000	0.000	0.000	0.000	A	-0.000	A	60	140	0
12	*	*	*	*	*	*	B	*	B	*	*	*
13	0.000	0	0.000	0.000	0.000	0.000	L	0.000	L	60	140	0
14	0.000	0	0.000	0.000	0.000	0.000	E	0.000	E	60	140	0
15	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
16	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
17	*	*	*	*	*	*		*		*	*	*
18	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
19	*	*	*	*	*	*		*		*	*	*
20	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
21	-0.000	50	-0.000	0.000	0.000	0.000		-0.000		60	140	0
22	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
23	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
24	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
25	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
26	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
27	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
28	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
29	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
30	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
31	0.000	0	0.000	0.000	0.000	0.000		0.000		60	140	0
SUM	-0.000	-	-0.000	0.000	0.000	0.000	N.A.	-0.000	N.A.	-	-	0
AVG	-0.000	50	-0.000	0.000	0.000	0.000	N.A.	-0.000	N.A.	60	140	0
NBS	Q302	N300	Q300	Q303	Q301	Q305	Q306	Q311	Q313	N305	N307	N308

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND — SOLAR/1056-78/12
REPORT PERIOD: DECEMBER,1978

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	OPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.237	74	0.175	0.036	0.061	0.061	N	0.071	N	67	35
2	0.252	74	0.186	0.039	0.065	0.065	O	0.077	O	67	44
3	0.313	74	0.231	0.048	0.082	0.082	T	0.097	T	66	33
4	0.139	73	0.101	0.023	0.038	0.038		0.044		68	55
5	0.209	72	0.152	0.034	0.057	0.057	A	0.064	A	68	43
6	0.183	74	0.135	0.029	0.048	0.048	P	0.056	P	68	44
7	0.180	74	0.134	0.027	0.046	0.046	P	0.055	P	68	43
8	0.156	73	0.113	0.025	0.043	0.043	L	0.049	L	68	52
9	0.198	73	0.146	0.031	0.053	0.053	I	0.062	I	68	45
10	0.313	74	0.231	0.049	0.082	0.082	C	0.097	C	66	27
11	0.371	73	0.269	0.062	0.102	0.102	A	0.108	A	67	24
12	*	*	*	*	*	*	B	*	B	*	*
13	0.316	71	0.226	0.056	0.090	0.090	L	0.091	L	67	31
14	0.293	68	0.198	0.063	0.095	0.095	E	0.069	E	67	34
15	0.307	66	0.202	0.069	0.104	0.104		0.058		67	39
16	0.240	67	0.160	0.052	0.080	0.080		0.049		67	42
17	*	*	*	*	*	*		*		*	*
18	0.415	74	0.306	0.067	0.109	0.109		0.125		65	28
19	*	*	*	*	*	*		*		*	*
20	0.350	71	0.248	0.064	0.102	0.102		0.098		68	30
21	0.270	68	0.185	0.055	0.086	0.086		0.072		67	42
22	0.336	71	0.239	0.062	0.097	0.097		0.089		67	34
23	0.296	73	0.215	0.050	0.081	0.081		0.083		67	37
24	0.265	74	0.196	0.041	0.069	0.069		0.081		68	34
25	0.325	73	0.238	0.053	0.087	0.087		0.098		67	40
26	0.259	73	0.189	0.043	0.070	0.070		0.075		67	34
27	0.337	74	0.250	0.052	0.087	0.087		0.104		67	30
28	0.485	75	0.362	0.074	0.124	0.124		0.149		65	27
29	0.374	76	0.283	0.057	0.091	0.091		0.107		66	25
30	0.303	76	0.230	0.045	0.073	0.073		0.095		67	31
31	0.281	74	0.209	0.044	0.072	0.072		0.087		68	40
SUM	8.857	-	6.429	1.493	2.428	2.428	N.A.	2.558	N.A.	-	-
AVG	0.286	73	0.207	0.048	0.078	0.078	N.A.	0.083	N.A.	67	36
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: M.F. SMITH, JAMESTOWN, RHODE ISLAND
REPORT PERIOD: DECEMBER,1978

SOLAR/1056-78/12

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	1425	N	35	39	N	N	N
2	1225	O	44	50	O	O	O
3	542	T	33	31	T	T	T
4	134		55	55			
5	642	A	43	46	A	A	A
6	1754	P	44	51	P	P	P
7	1019	P	43	48	P	P	P
8	300	L	52	54	L	L	L
9	120	I	45	44	I	I	I
10	1019	C	27	29	C	C	C
11	958	A	24	28	A	A	A
12	*	B	*	*	B	B	B
13	1019	L	31	35	L	L	L
14	857	E	34	38	E	E	E
15	804		39	43			
16	1242		42	47			
17	*		*	*			
18	2507		28	31			
19	*		*	*			
20	286		30	32			
21	546		42	46			
22	1725		34	38			
23	1734		37	44			
24	790		34	38			
25	534		40	41			
26	1805		34	37			
27	1471		30	33			
28	1866		27	30			
29	1784		25	31			
30	1363		31	38			
31	208		40	43			
SUM	32856	N.A.	-	-	-	-	-
AVG	1060	N.A.	36	40	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

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